2724

Optical Access in the BREAD Roadmap

P. Van Daele

IMEC – Gent University, INTEC Dept., Gaston Crommenlaan 8 box 201, B-9050 Gent-Ledeberg
Tel: +32-9-331 49 06, Fax: +32-9-331 48 99, e-mail: peter.vandaele@intec.ugent.be

Abstract: The FP6-BREAD - co-ordination action aims at developing a multi-disciplinary approach for the realization of the 'Broadband for All' concept within Europe. It performs a multi-technological analysis of the current and evolving situation, starting from roadmaps generated by different IST instruments focusing on specific technological domains. BREAD also studies the techno-economic, societal and regulatory aspects. This paper mainly focuses on the information collected by BREAD on the use of photonics in the access domain, in which optics compete with other technologies.

Keywords: Broadband for All, Photonics Roadmap

1. Introduction

The BREAD (BRoadband in Europe for All: a multi-Disciplinary approach) co-ordination action aims at developing a multi-disciplinary approach for the realization of the 'broadband for all' concept within Europe. This EU objective will not be reached by a solely 'technology push' strategy but will need a multi-disciplinary approach (societal, economic, regulatory and technological issues). Bringing all these different disciplines together, sharing views and knowledge, developing new strategies and good practice recommendations in the area of 'broadband for all' is the major objective of the BREAD proposal.

As a co-ordination action the project wants to bring together all players active in the field of the end-to-end broadband provisioning. It performs a multi-technological analysis of the current and evolving situation taking as a starting base all the roadmap information generated by different IST instruments and projects focusing on specific technological domains. The BREAD consortium studies at the same time the techno-economic, societal and regulatory aspects of this "broadband for all" concept. It tries to cover the evolution in BroadBand in EU countries and some relevant country cases all over the world. This study includes regional "success stories" of actual deployment and the influence of government stimulus for accelerating the early rollout of broadband services.

The BREAD project is setting up an IST co-ordination and information exchange platform to enhance the interaction between the key players in the field and to invoke discussions on this multi-disciplinary approach. The Broadband cluster/Forum set up by BREAD supports the creation of the European Research Area (ERA) through the stimulation of the interaction of EU national initiatives and projects. The BREAD project has initiated a yearly "BB EUROPE" event (www.bbeurope.org) which brings together all players involved in the R&D and the implementation of Broadband for All in Europe and presents information on trials, projects and initiatives taken in the field.

The project has also organized and co-organized workshops such as: "Broadband Roadmap" (10/03/04), "Shaping the Broadband Society" (24/08/04), "QoS" (09/03/05), "Fixed-wireless/mobile-satellite convergence" (23/06/05), "Techno-Economic feasibility of Broadband for All" (23/09/05), "Universal Broadband Access in Europe: What role for photonics?" (25/09/05). Copies of the presentations are available trough the BREAD-website.

2. The BREAD Roadmap

2.1 Introduction

The major result of the BREAD-project at this time is the publication of the deliverable "Second Report on the Multi-Technological Analysis of the 'Broadband for All Concept with'" of this FP6-project "Broadband in Europe for all: a multi-disciplinary approach project (BREAD)". It contains an update of the listing of multi-technological key issues, a first gap analysis and first roadmaps on how to tackle these issues. It is a combined deliverable on the multi-technological and multi-disciplinary analysis of the "broadband for all" concept. The major objective of this second deliverable (D2.2.-3.2) is to identify and outline the most important areas in relation to the multi-technological and multi-disciplinary analysis of the "broadband for all" concept. This means that an overview is given on evolutions around the world in the different technological disciplines with a first indication of trends and expected scenarios.

The deliverable also includes a complete set of EU country studies on broadband development, as well as case studies of a small number of non-EU key broadband countries. (US, Japan, South Korea, Iceland and Canada). In particular, the five non-EU countries as well as five EU member states (Finland, Sweden, Germany, Denmark, UK) are examined more in-depth than the other 20 EU member states. The analysis includes an empirical account of the drivers of broadband use and diffusion, alternative policy approaches and their impacts, and social, cultural and economic factors that have shaped and that are expected to shape broadband take-up. In addition, a synthesis of the results of all country studies is provided, as well as an examination of how the issue of usability affects broadband development.

The deliverable is a public document and is available via the website http://www.ist-bread.org or by sending an e-mail to breadmaster@intec.ugent.be. More information on the different sections of the document are given in the following sections of this paper.

ISBN: 0-7803-9789-4/06

2.2 The BREAD Strategy

In the BREAD-project and the deliverable, a summary is given of the different technologies and trends in the broadband for all areas, which considers different inputs:

- The user, market and convergence trends described in the rest of the document
- The technology state of the art and trends, which have been produced in coordination with the other involved IST project, as well as with external projects and initiatives
- The future inputs of a think tank initiative which is set-up by the project.

The methodology (shown below in Figure 1) adopted to build a coherent set of requirements and roadmaps in the different areas of interest follows an hybrid top-down / bottom-up approach.

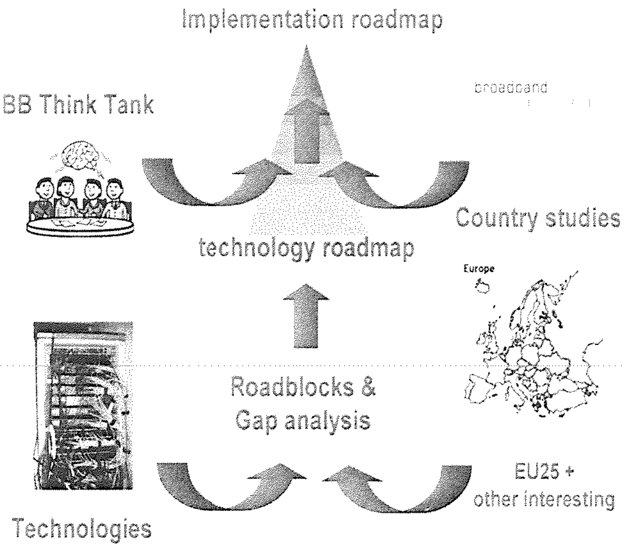

Figure 1 : Strategy followed in the BREAD-project to define roadmaps and strategic documents

Some technical requirements are well known, and a complete framework can be derived. A high level vision, and the pre-study of the state of the art analysis in the different technical domain covered by "Broadband for All" will allow to refine the gap analysis and the technology roadmap derived.

The initial set of requirements which has been considered in the analysis is being segmented between the Application/Service Provider, the Network Operator, and the User. These can be translated in a set of technical requirements and trends, which are considered for the establishment of the gap analysis and roadmaps in the following chapters. The study of these technical requirements and trends require to segment the Broadband for all into technical areas.

The breakdown between domains tries, to align to the separation between networks and actors of the broadband chain: there is a natural separation between Home network, Access technologies, Metro Network on one end, and horizontal boundaries between the network operator, service / application providers, and content providers on the other end (the latter domain being out of scope of the document).

3 Photonics in the BREAD Roadmap

3.1 Introduction

"All-Optical" is the vision for future wired networks, where we use fibre for all wires in the WAN, MAN and Access. Nowadays, optical fibres are ubiquitous in the backbone network, and an extension to access networks is the logical next step. BREAD also looks into the evolution of photonics in the Core and Metro network, but for this information we refer to the documents on the BREAD website (www.ist-bread.org).

An optical fibre based access network offers of all available technologies by far the highest speed and can support an unlimited set of services. FTTx (Fibre to the x, where x stands for Curb or Cabinet (C), Premises (P), Building (B), Home (H), Desk (D)) would thus be a future-proof access solution.

With FTTH or FTTB the optical connection reaches the home of the building of the end-user. This implies a tremendous investment. Fibre to the Curb or Cabinet (FTTC) will bring the optical fibre to a service node in a nearby location outside the customer premises, which is a more cost-effective solution.

Traditionally, an optical fibre access network was not realistic due to the very high installation and equipment cost. Dropping cost of the end equipment and new roll-out techniques will make FTTx however a feasible option. At the moment, optical components are getting cheaper but are still relatively expensive, and it is important the service fees meet the consumer price points.

Finally, are their sufficient applications for the huge bandwidths that come available with FTTx? There are some potential drivers, but their extent of demand is not clear: e.g. Video Conferencing, Multimedia Entertainment, Long Distance Learning, Gaming, Video on Demand. And will increasing bandwidth spur on new applications or will new applications spur bandwidth? Speed seems the most important driver for new applications, according to the view of the leading broadband countries in Asia.

3.2 State of the Art

The ultimate goal is to bring the fibre to the home user by replacing the existing copper/coax cables. The evolution of the network will therefore be limited to the part going from the central office (CO) to the home user.

An important distinction is the choice between point-to-multipoint (P2MP) and point-to-point (P2P) connections. Nowadays, the most important point-to-multipoint configuration of an optical access network is a (power splitting) time division multiplexing (TDM)-based passive optical network (PON). Current TDM-PON standards specify the line rate up to 2.5 Gb/s and maximum link reach of 20 km, and typically with a split ratio of 1:32.

In the first-generation optical access networks, the major thrust has been economical deployment, and a power splitting PON was the most opportune solution. Nowadays, the cost of optical devices has decreased a lot, and design considerations other than cost will become important. To overcome some of the demerits of a pure power splitting TDM-PON, interest has grown in WDM PONs. WDM has been considered an ideal solution to extend the capacity of PONs without drastically changing the currently deployed fibre structure.

Instead of having a PON, it is also possible to deploy an active network, which looks very similar to a PON, however with some important differences. The most

ISBN: 0-7803-9789-4/06

fundamental one is to replace the passive, unmanageable splitters in the field by an active node. Second, instead of sharing bandwidth among multiple subscribers, each end user is provided a dedicated connection that provides full bi-directional bandwidth. The third architectural difference is the distance limitation where an active network has a distance limitation of ca. 80km, regardless of the number of subscribers being served.

3.3 Socio Economic Issues

By the end of June 2004, there were approximately 550000 FTTx subscribers in Europe (EU25 + Norway & Iceland) (Figure 2). This means only between 1.5% and 2% of the broadband connections are provided by FTTx.

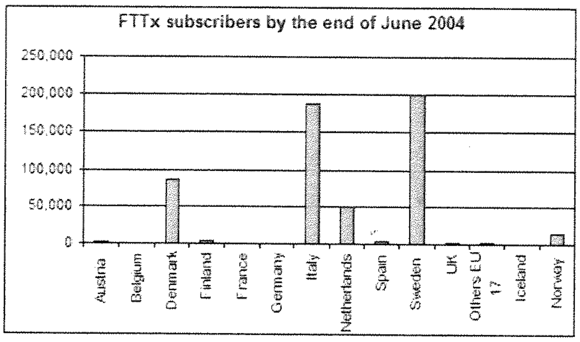

Figure 2 : FTTx subscribers by the end of June 2004 (Source: IDATE)

There were 167 locations where FTTx initiatives have been launched, and 103 players were involved in (Table 1). Among them, nearly 70% are municipalities or power utilities. Furthermore, approximately 60% of these deployments are at commercial phase, 20% are pilots and 20% are at a project phase.

Incumbent operators	8	7,8%
Municipalities / power utilities	72	69,9%
Alternative operators / ISPs	9	8,7%
Housing companies & Other	14	13,6%

Table 1: Players involved in FTTx initiatives in Europe

Outside Europe, important FTTx countries are Japan, South Korea and Hong Kong, they are the world leaders in the field of FTTx.

Finally, an important point to stress is that most of the FTTx deployments in Europe (e.g.: Sweden: Stockholm, Italy: Milan, The Netherlands: Eindhoven, Amsterdam) as well as in Japan, South Korea and Hong Kong, are installed in densely populated cities. In the USA, we see most of the FTTx deployments are rather in rural areas, especially in green field areas. The distinction between the USA and the rest of the world can be declared by the fact that the size and population distribution of the USA is distinct from the other countries. The subscriber loop lengths are typically longer in the USA, and by consequence the cost per resident to roll out a FTTH network is higher. This declares why in the USA FTTx is mainly attractive in green field, but not in more densely populated areas.

3.4 Gap analysis

Technologically, there are two important challenges for the future: increasing capacity and extending the distance between CO and user. The extension to WDM-PONs therefore gains interest. Another important topic is the cost of the optical components, especially for the ONUs. Maturity of optical components and large-scale integration/manufacturing of ONU have dropped the prices.

Finally, considering the deployment of FTTx, the following factors are essential:

- Policy/regulatory support, either active participation by the government by financial support (cf. Sweden, The Netherlands), or passive by creating a positive regulation climate (cf. Japan, South Korea).
- The interest of the incumbent telecom operators (cf. Japan, South Korea).
- Advanced (new) services that can create a clear revenue opportunity.

3.5 Roadmap

FTTB and FTTH can be regarded as the logical endpoint of an ongoing evolution. In the pre-fibre days, Telco COs were interconnected by coax and microwave, while cable head ends were fed by microwave or satellite. The first step in "fiberizing" the entire system was Hybrid Fibre Coax (HFC) (being widely deployed by the cable industry today), in which the node becomes an optical network unit. HFC serves several hundred homes per fibre end, each using copper (coax) in both directions between "node" and subscriber, but with limited bit rate and very demanding design rules.

The slowly emerging Fibre to the Curb (FTTC) systems split each upstream or downstream fibre into 10-100 subscriber copper paths. It is not clear that FTTC systems offer any economic advantage over full FTTH/B, which is just the logical extension of HFC to FTTC to a single subscriber per fibre. Because of its non-optimum economics, FTTC is likely to be overtaken by the clean passive-all-the-way FTTH option, i.e. PON.

The current PON technology mainly uses power splitting PONs, but (C)WDM is another important PON approach, which will gain more and more interest in the future.

Another all-fibre solution is the active architecture, which gains more and more interest. Active Ethernet is quietly becoming the preferred choice among leading service providers worldwide for their fibre deployments.

An Active architecture has one arguable drawback from a deployment perspective, and that is the requirement for power in the outside plant. However, Active electronics in the field are nothing new and many Telco's have already powered electronics in the field.

4. Acknowledgment

The material used in this paper is fully taken from BREAD-work carried out by all of the BREAD-partners:

- IMEC - INTEC Department at Ghent University (Belgium);
- The Electronic Systems Engineering Department of the University of Essex (United Kingdom);
- COM / Center for Tele-Information at the Technical University of Denmark (Denmark);
- The Communications & Electronics Department at the GET/TELECOM PARIS-Ecole Nationale Supérieure des Télécommunications (France);
- The Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut (Germany);
- Telscom Consulting (Switzerland);
- Institute for Prospective Technological Studies, Directorate-General Joint Research Centre, European Commission (Spain);
- JCP-Consult Sarl (France).

We therefore would like to thank all of the BREAD-partners for their work and would like to refer to the BREAD-website (www.ist-bread.org) and the BREAD-publications, available through the website, for more detailed information.

ISBN: 0-7803-9789-4/06

2006 International Conference on Photonics in Switching

Capsis Beach Hotel
Heraklion, Crete,
Greece

PROCEEDINGS

2006